BIG

Revolutionizing how customers build, deploy and operate highly available and scalable services

Application Platform Infrastructure Team
Windows Server Product Group
Microsoft Corporation

June 19, 2002

Agenda

- Vision
- Architecture
  - *Hardware Reference Platform*
  - *Resource Management*
  - *IBIG*
  - *Service Definition Model (SDM)*
  - *Operations Logic*
- Customers and Scenarios
- Wrap-up

The Broad Vision

- **Enable**
  - ***development*** *of distributed, scalable and highly available services using Visual Studio and* ***reusable*** *building blocks like SQL, IIS, …*
  - ***deployment*** *across a set of* ***abstracted*** *hardware resources that are automatically allocated, purposed and configured*
  - ***lower cost of ownership*** *through automation by codifying operational best practices to control service availability and growth*
  - ***procurement*** *of standardized data center hardware that leverages* ***commodity economics***

BIG *is a revolutionary re-think of the way highly available and scalable services are built, deployed, operated*

BIG Will Deliver a Services Platform

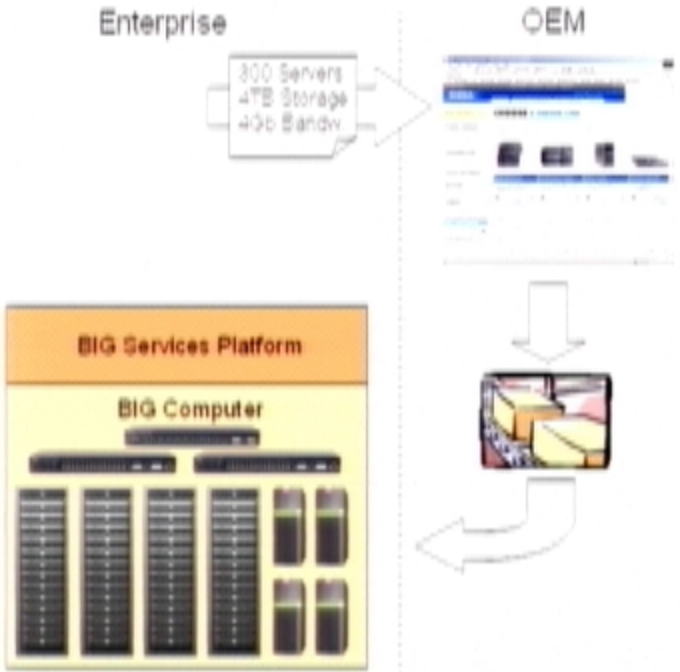
- **Hardware reference platform that aggregates commodity hardware to build a single large computer that we call the BIG Computer**
  - *Includes interconnected servers, network devices, and storage*
- **Hardware abstraction layer that virtualizes resources**
  - *Enables dynamic hardware binding and re-deployment and automated network configuration*
- **Service Definition Model (SDM) for developers to describe an entire service**
  - *Enables developers to rapidly build new services using highly available SQL, IIS and other reusable building block components*
  - *Requires incremental changes to BIG enable existing services*
- **Highly available runtime that supports the SDM**
  - *Enables hosting multiple scalable services inside the BIG Computer*
- **Operations logic framework for automating operational best practices**
  - *Enables policy expression and enforcement*

BIG Ecosystem

Enterprise

BIG Ecosystem

BIG Ecosystem



BIG Ecosystem

Developer

Enterprise

OEM

BIG Ecosystem

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ASP.NET

Enterprise

OEM

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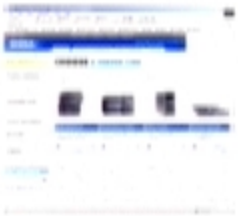

BIG Ecosystem

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ASP.NET

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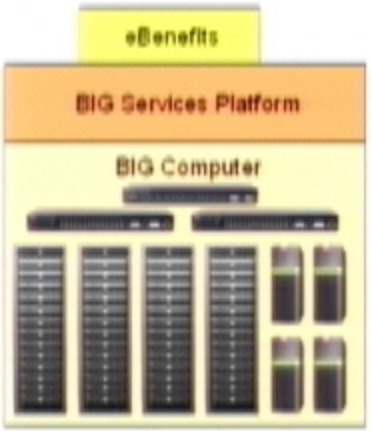
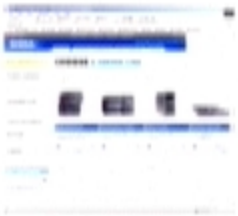
Operations Logic

Enterprise

300 Servers
4TB Storage
40b Bandw



OEM



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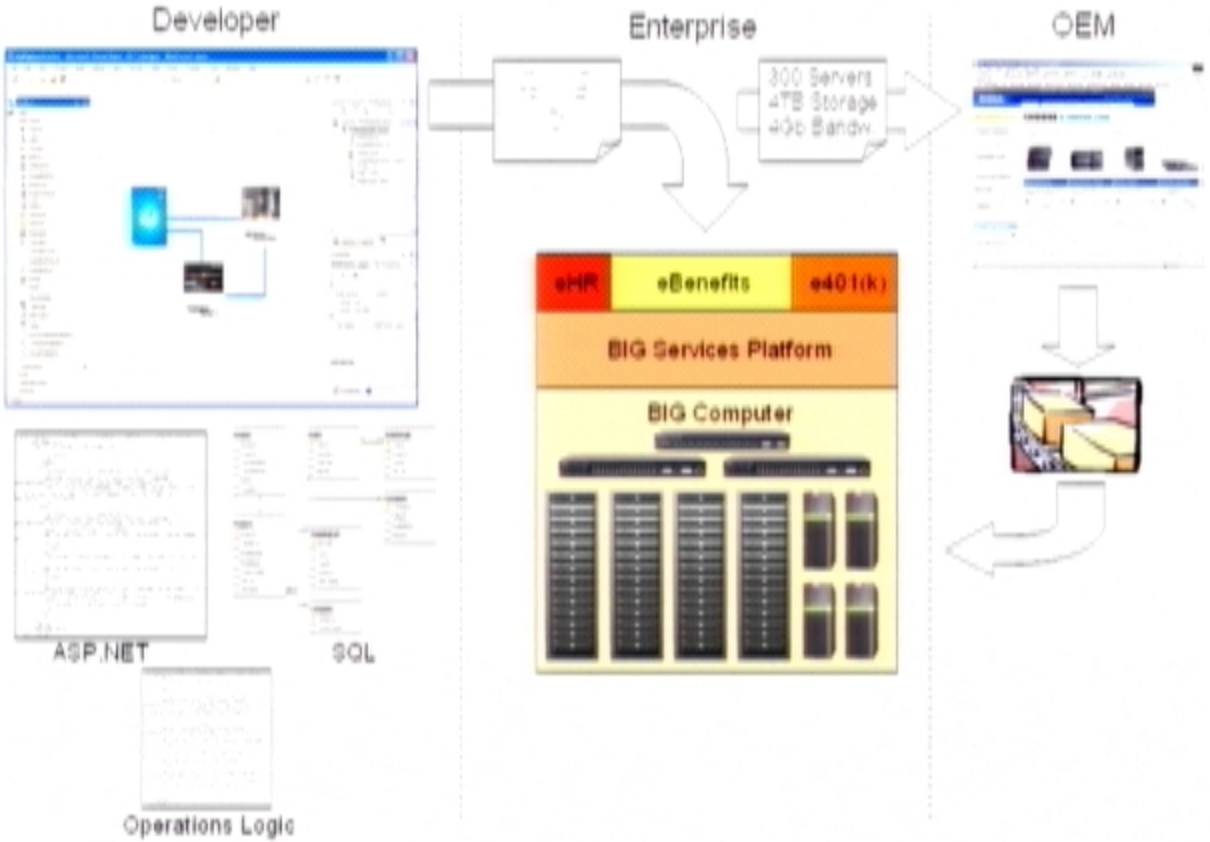

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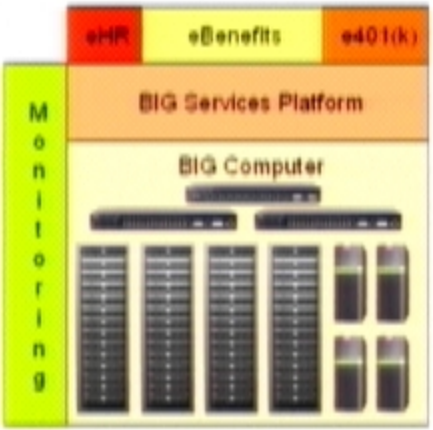
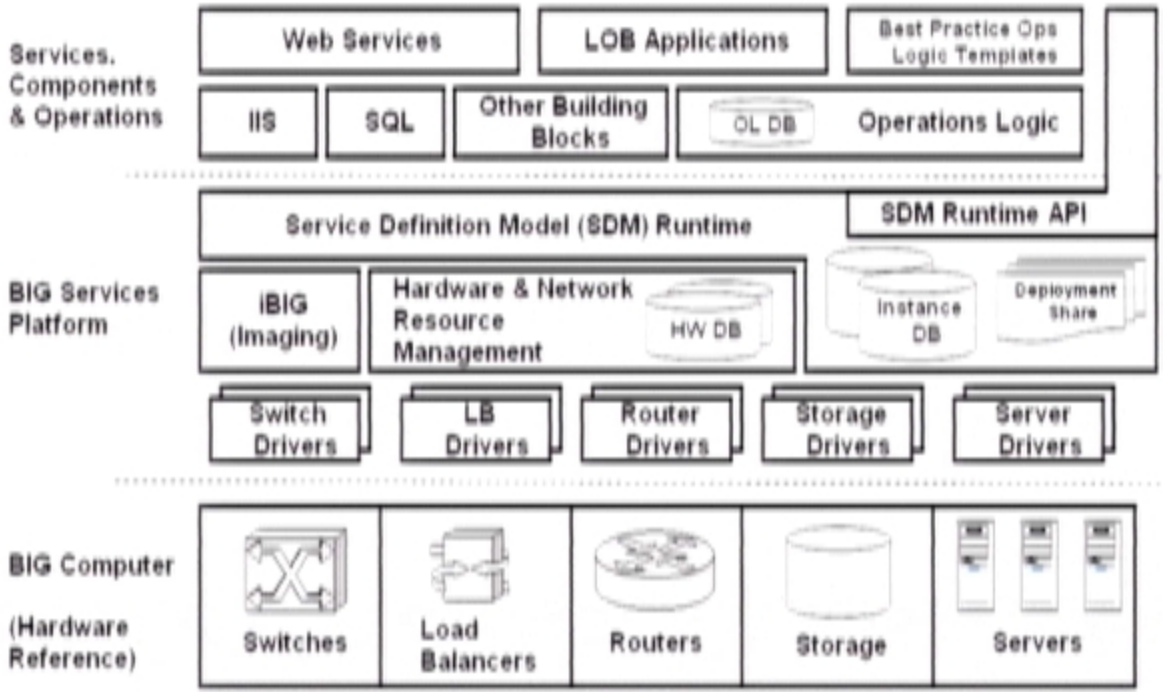


ASP.NET

SQL

Operations Logic

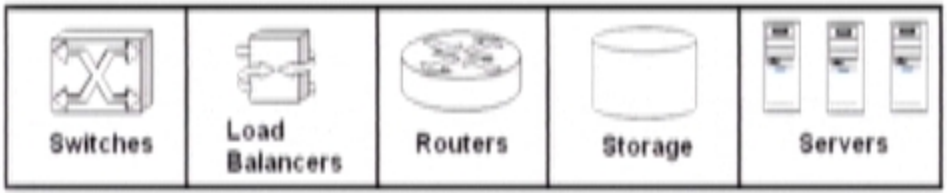
BIG Services Platform Architecture



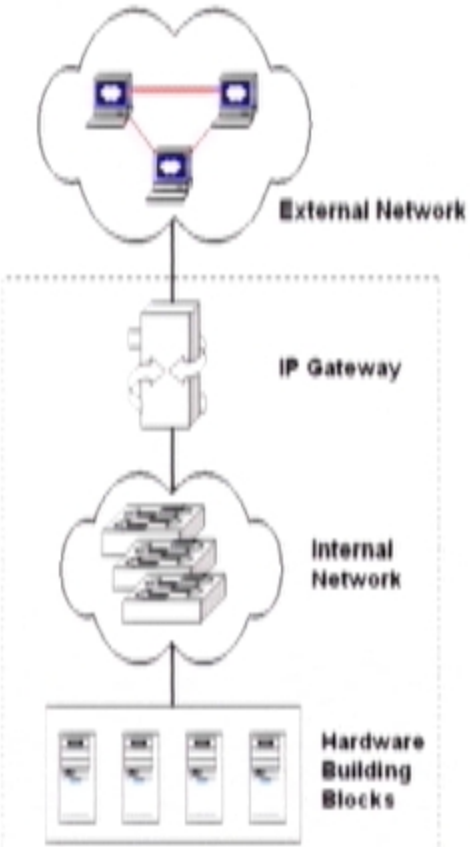
Hardware Reference Platform Initiative

BIG Computer

(Hardware Reference)



Hardware Reference Platform (BIG Computer)



Motivation

- Reduces the cost of design, test and operations
- Limits number of hardware devices to support
- Constrains the network topology and enables automation of network configuration
- Customers adverse to BIG taking over the entire data center (PXE, DHCP, DNS, network switches)

IP Gateway

- *Mediates IP traffic between the external network and the internal network*
- *Network Address Translation (NAT)*
- *ISA for firewall functionality*
- *Load Balancing*

Internal Network

- *IP addrs and VLANs are managed exclusively by BIG*
- *VLANs are automatically configured*

Hardware Building Blocks

- *Combinations of commodity servers, network switches, routers and disks*

Examples of Current Products that can be Inside a BIG Computer

BL10e

3U enclosure (20 blades)

7U enclosure (14 blades)

Compaq Proliant BL e-class

- Pentium III 700MHz
- 512MB – 1GB EC C RAM
- 30GB ATA Hard Disk
- Dual 10/100 Fast Ethernet
- Layer 2 switch with Gigabit uplinks
- Redundant 600 W power supplies
- 280 blades per 42U rack (2kW per slot)

IBM BladeCenter

- Dual Xeon
- 1GB EC C RAM
- 1 pci or Fibre Channel storage
- 4x Gigabit Ethernet
- 4x 1200 W power supplies
- 84 blades per 42U rack

Dell PowerEdge 1655MC

- Dual Pentium III 1.2GHz
- 1GB – 2GB EC C RAM
- 36-146 GB SCSI Hard Disk
- Dual Gigabit Ethernet
- 2 Layer 2 switches with Gigabit uplinks
- Redundant 1400 W power supplies
- 14 blades per 42U rack

3U enclosure (6 blades)

bh7800 rack (16 blades)

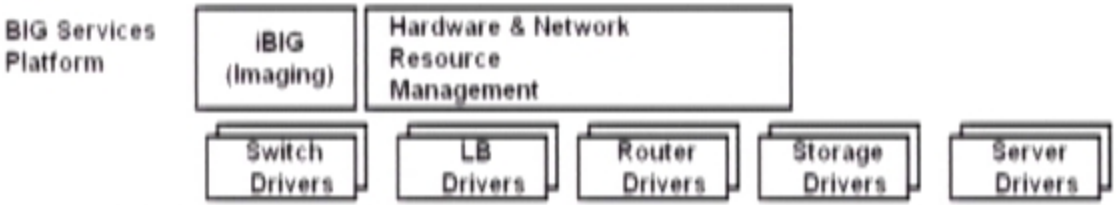
HP bc1100

- Pentium III 700MHz
- 512MB EC C RAM
- 30GB IDE Hard Disk
- Dual 10/100 Fast Ethernet
- 2 Layer 2 switches with Gigabit uplink
- Redundant 1200 W power supplies
- 80 W per slot
- 16 server blades per 19U rack

Fabric blades

- 1 Management blade
- 2 Management LAN blades
- 2 Network switch blades
- Storage blades (CE)

Infrastructure Services



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- Layer 2 switch with Gigabit uplinks
- Redundant 600 W power supplies
- 280 blades per 42U rack, 25W per slot

IBM BladeCenter

- Dual Xeon
- 2GB ECC RAM
- 1 SCSI or Fibre Channel storage
- 4x Gigabit Ethernet
- 4x 1200 W power supplies
- 84 blades per 42U rack

Dell PowerEdge 1655MC

- Dual Pentium III 1.2GHz
- 1GB – 2GB ECC RAM
- 36-146GB SCSI Hard Disk
- Dual Gigabit Ethernet
- 2x Layer 2 switches with Gigabit uplinks
- Redundant 1040 W power supplies
- 24 blades per 42U rack

3U enclosure (6 blades)

bh7800 rack (16 blades)

HP bc1100

- Pentium III 700MHz
- 512MB ECC RAM
- 30GB IDE Hard Disk
- Dual 10/100 Fast Ethernet
- 2x Layer 2 switches with Gigabit uplink
- Redundant 1200 W power supplies
- 80 W per slot
- 16 server blades per 19U rack

Fabric blades

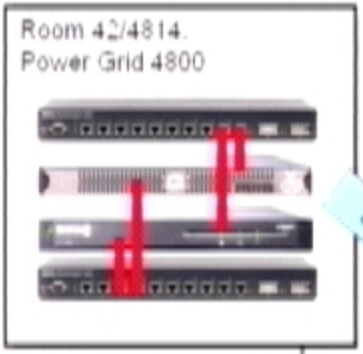
- 1 Management blade
- 2 Management LAN blades
- 2 Network switch blades
- Storage blades (CE)

BIG Resource Management

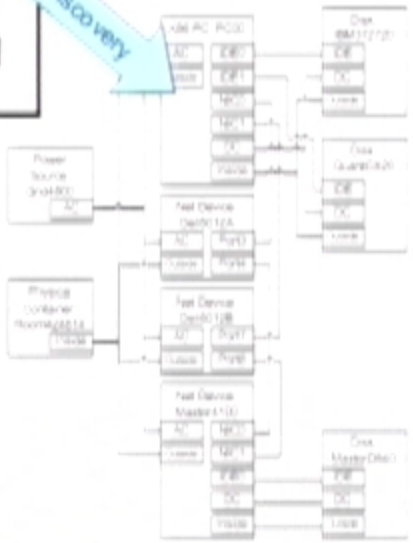
- **Global Resource Manager automatically allocates resources and binds services to the BIG Computer**
  - *Hardware devices are discovered and exposed as virtualized resources*
- **Resource providers**
  - *IIS VRoots*
  - *SQL Databases*
  - *CLR AppDomains*
  - *Win32 OS (iBIG for image deployment)*
  - *Network Resources*
  - *Bare metal PCs*
- **Resource Manager optimizes component placement to conserve valuable cross-sectional bandwidth and meet resource constraints**
- **Resource Manager frees operators from the detailed tasks of resource management**
  - *Automatically detects and updates system when new services or hardware are added to the BIG computer*
  - *Response to a failure event or policy action*

BIG Hardware Resource Discovery and Management

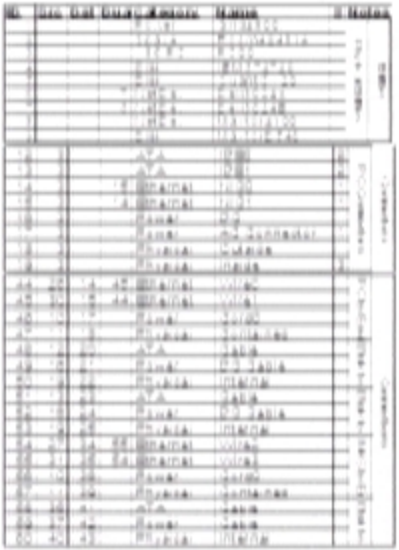
- Dynamic or static hardware discovery
- Resource drivers are bound to hardware devices and expose logical resources for allocation
- Allocation translates logical resource request to physical resource availability



Discovery



Physical Resource Graph



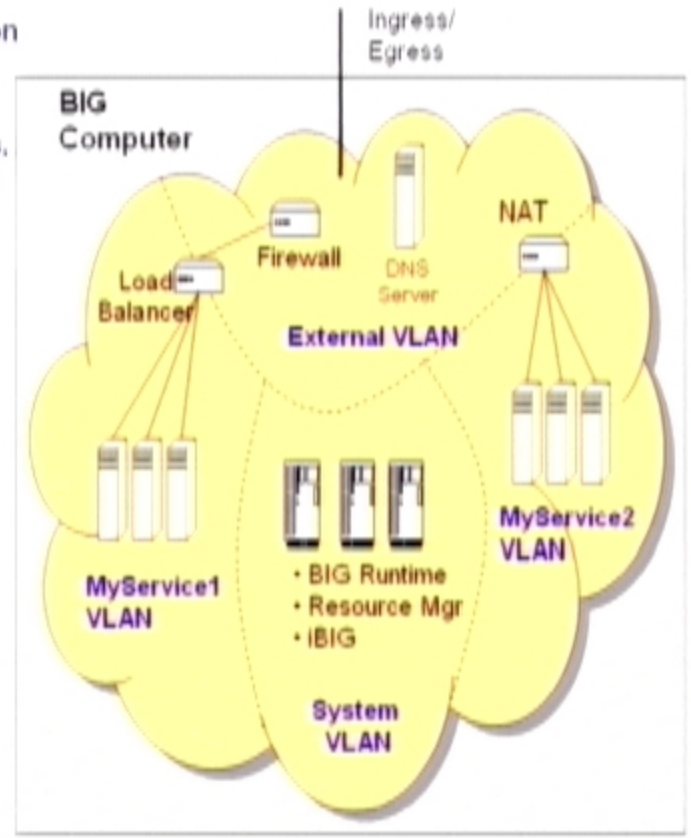
Physical Resource Database

Properties

- Power
- Network
- Storage
- Processor
- Memory
- Location

Network Management within the BIG Computer

- BIG Computer defines an abstraction layer for network resources
- BIG programs the network switches, load balancers and routers through software
- VLANs provide isolation
  - *Membership in a VLAN can be inferred from the BIG namespace*
- Network resources
  - *VLANs*
  - *Load Balancers*
  - *Firewalls*
  - *Routes*
  - *Network Filters*
  - *External IP addresses*
  - *External DNS Names*



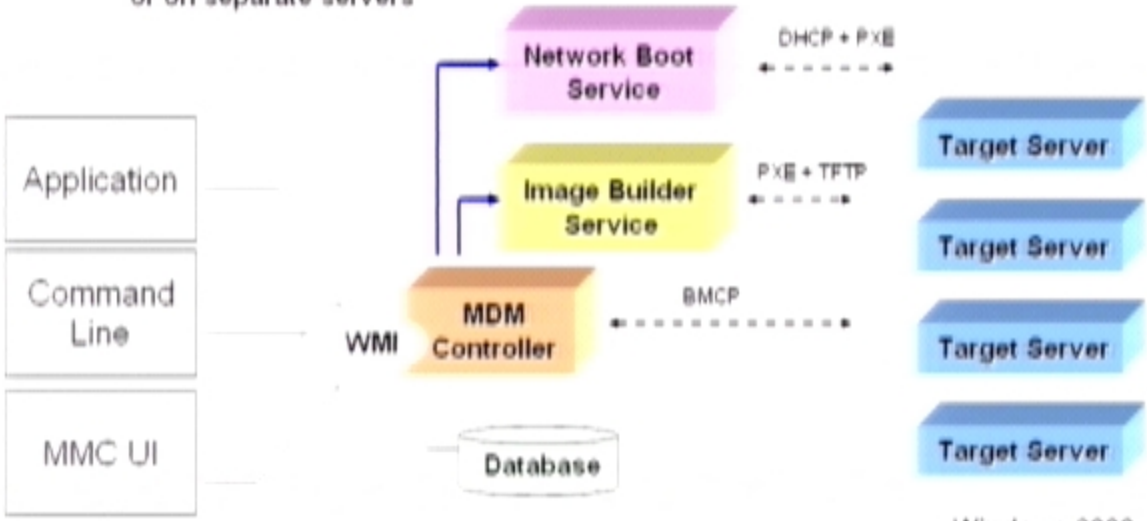
iBIG Features

- **Base Deployment Services**
  - *Basic Network Boot Service (PXE) and Image Builder Service*
  - *Pre-boot OS environment (BMonitor)*
  - *Virtual floppy delivered over network for legacy tools support*
- **Image Deployment and Management**
  - *Tools for creating, editing and deleting images*
  - *Deployment of images to systems running pre-OS*
- **Multiple Device Management (MDM)**
  - *Scripts for common tasks*
  - *Task sequencing to coordinate multiple steps and processes for deployment*
  - *Full programmatic interface (WMI)*
- **Supports Windows 2000 and .NET Server targets**

iBIG Architecture

Target servers run iBIG 'agent' to communicate with controller

Services can be co-located or on separate servers



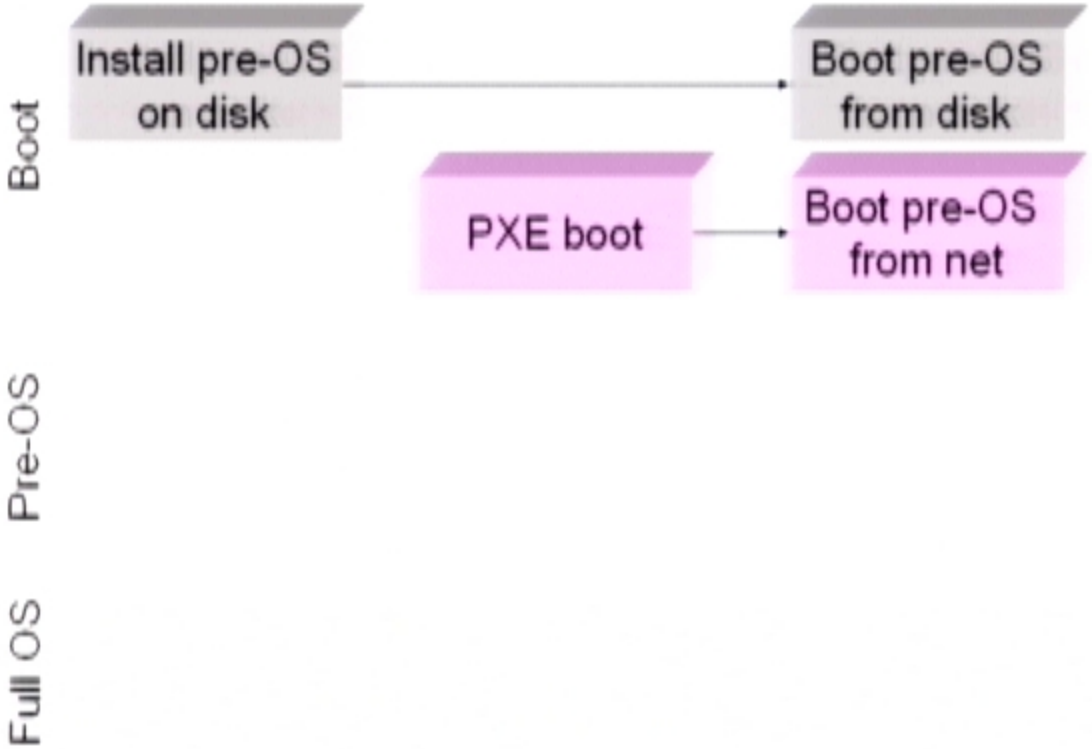
- Windows 2000
- .NET Server

- Controller runs only on .NET Enterprise Server
- WMI is the interface to the controller

Full OS Pre-OS Boot

Server Purposing

Server Purposing



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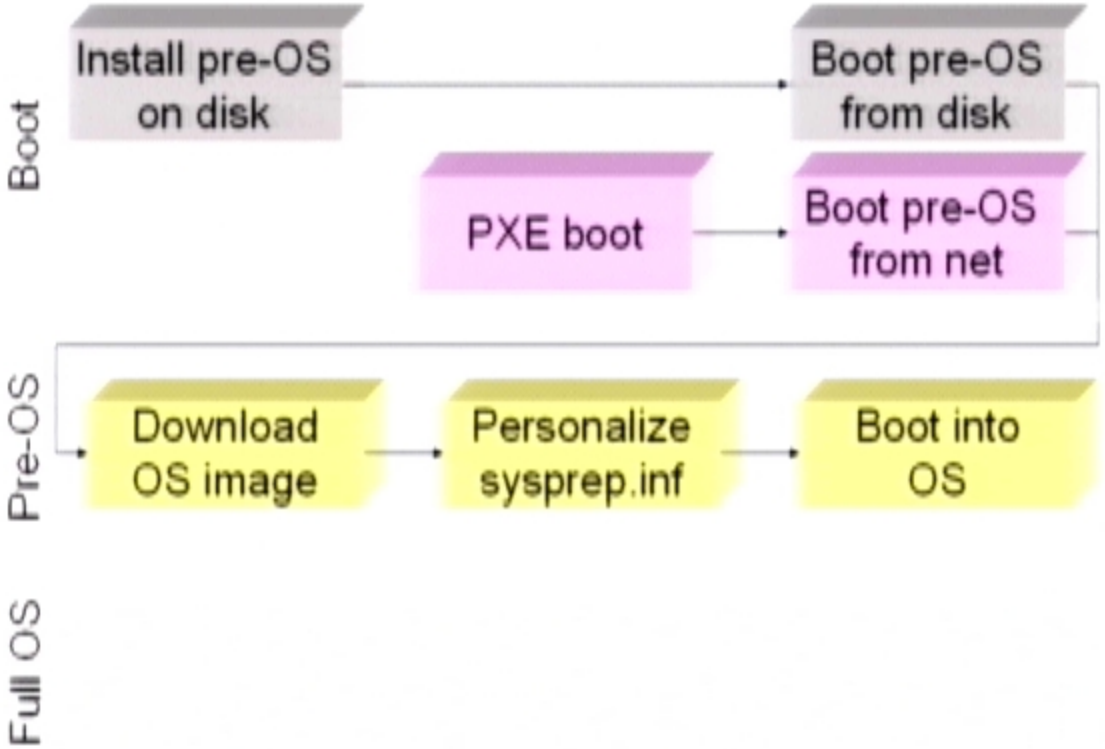

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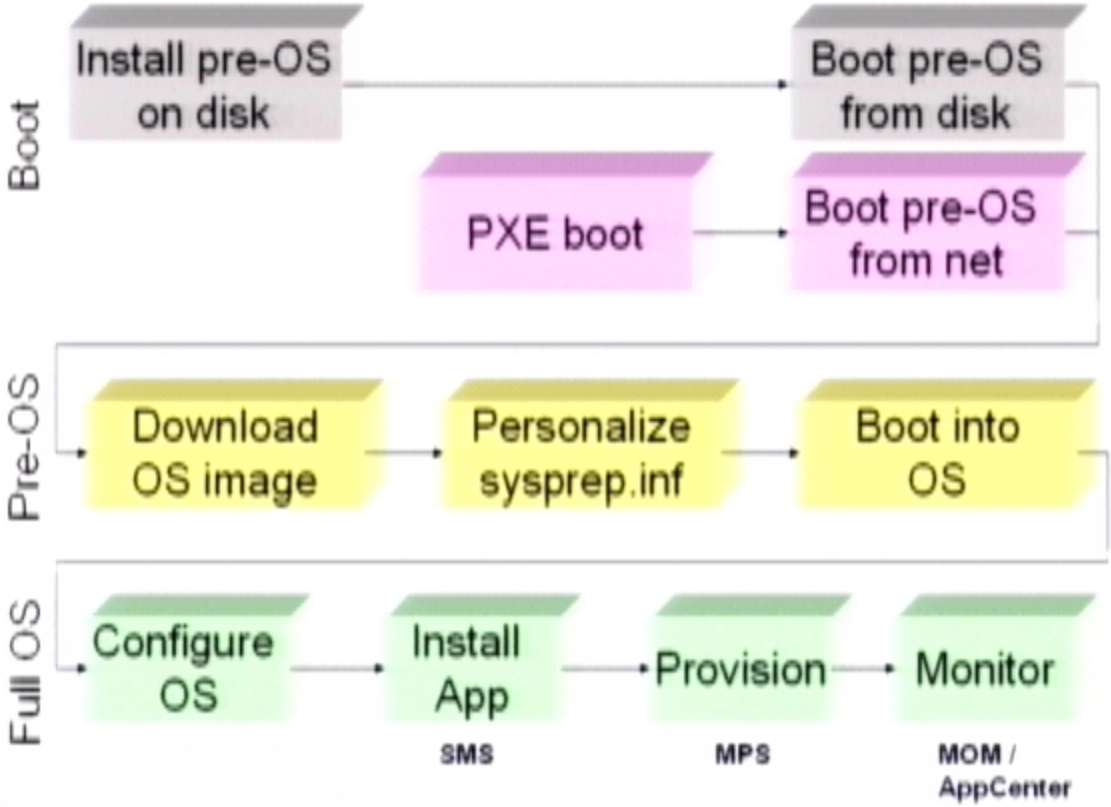
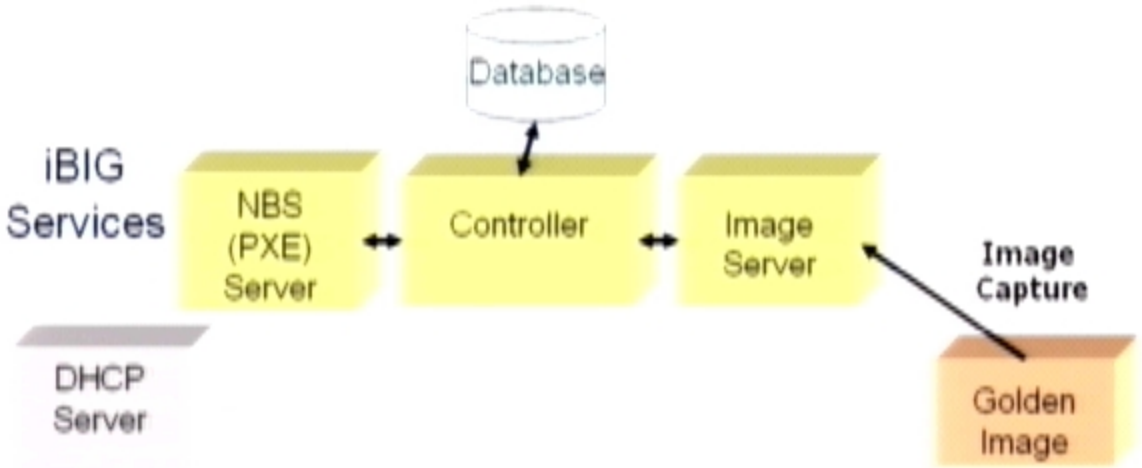


Remote Boot and Imaging



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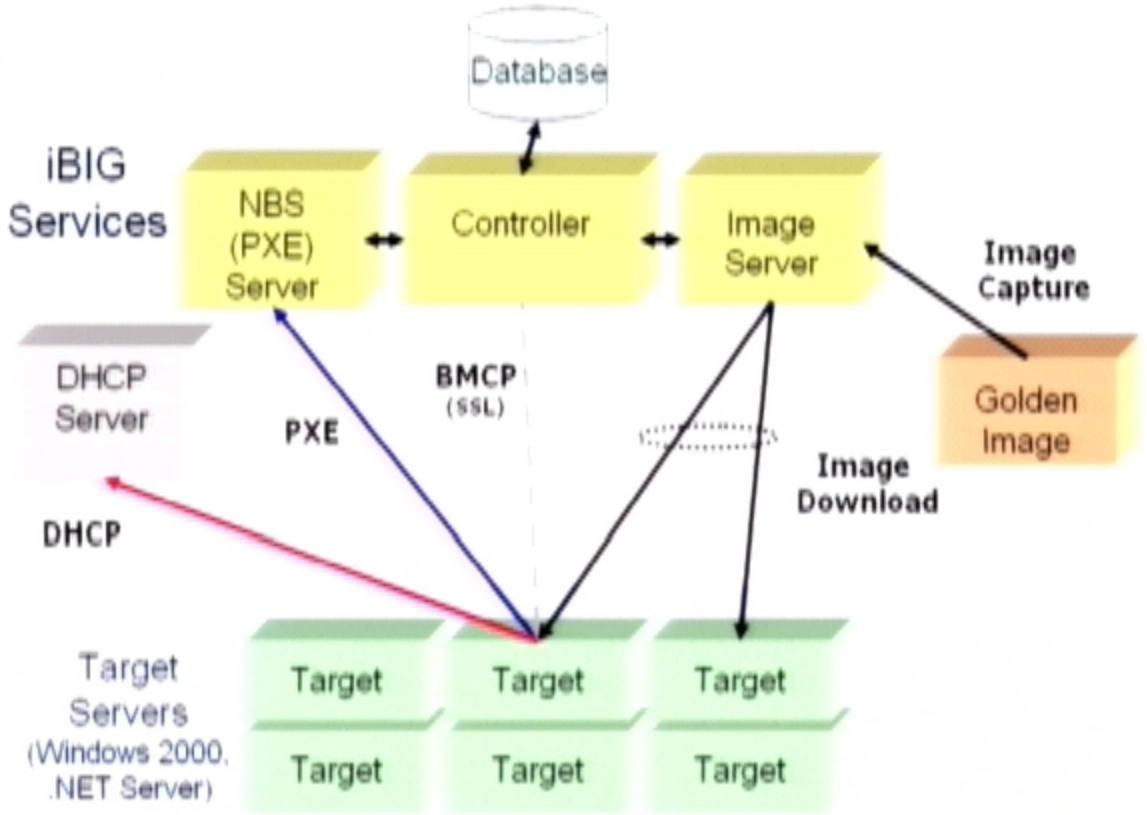

Service Definition Model (SDM)

- **The programmatic description of the entire service**
  - ***Declarative*** *definition of the service*
  - *Defines the overall* **service structure** *of the service in a* **scale-invariant** *manner*
  - *Provides a* **framework** *for deployment, management, and operations*
  - ***Component-based*** *model captures in a modular fashion the elements of a service*
- **SDML is the declarative language for defining Service Definition Models**

Components, Ports and Wires

- **Components are units of implementation, deployment and operations**
  - *For example, dedicated server running .NET Server, IIS virtual web site, SQL database.*
  - *Expose functionality through ports and communicate through wires*
  - *Compound components created by composition*
- **Ports are names (service access points) with an associated type (protocol)**
  - *BIG does not mandate what protocols to use for communication*
  - *Protocols capture the information required for establishing communication*
- **Wires are the permissible bindings between ports**
  - *Wires declare a topological relationship between ports*

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SDML Example: MyService.sdml

```
using System;
using System.SQL;
using System.IIS;
assembly name MyService;

componenttype MyFrontEnd :
   ASPApplication {
   port SQLClient catalog;
   implementation "MyFE, MyCLRApp"
}
componenttype MyBackEnd :
   SQLDatabase {
   implementation "MySQL, MyCLRApp"
}

componenttype MyService
{
   component MyFrontEnd fe;
   component MyBackEnd be;
   port http = fe.http;
   wire TDS tds {
         fe.catalog;
         be.sql;
   }
   implementation "MyService, MyCLRApp"
}
```

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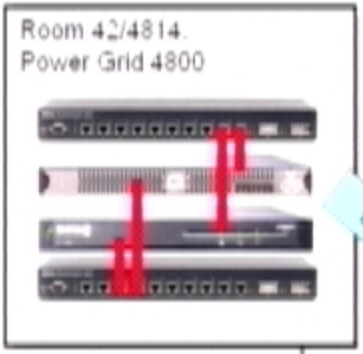

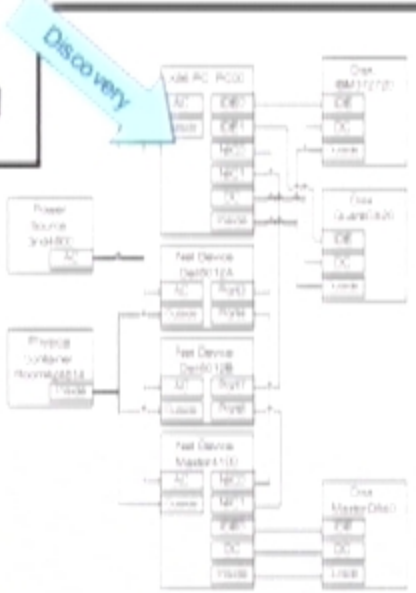

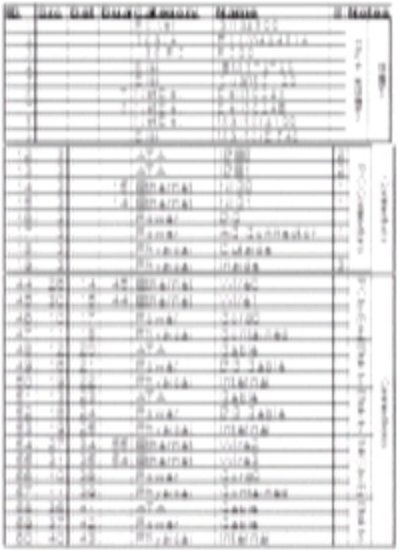

Physical Resource Graph

Physical Resource Database

Properties

- Power
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- Memory
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   ASPApplication {
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   implementation "MyFE, MyCLRApp"
}
componenttype MyBackEnd :
   SQLDatabase {
   implementation "MySQL, MyCLRApp"
}

componenttype MyService
{
   component MyFrontEnd fe;
   component MyBackEnd be;
   port http = fe.http;
   wire TDS tds {
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         be.sql;
   }
   implementation "MyService, MyCLRApp"
}
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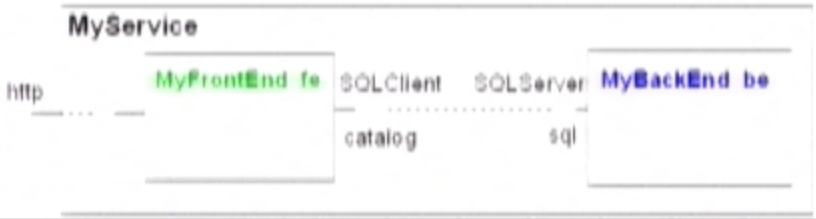
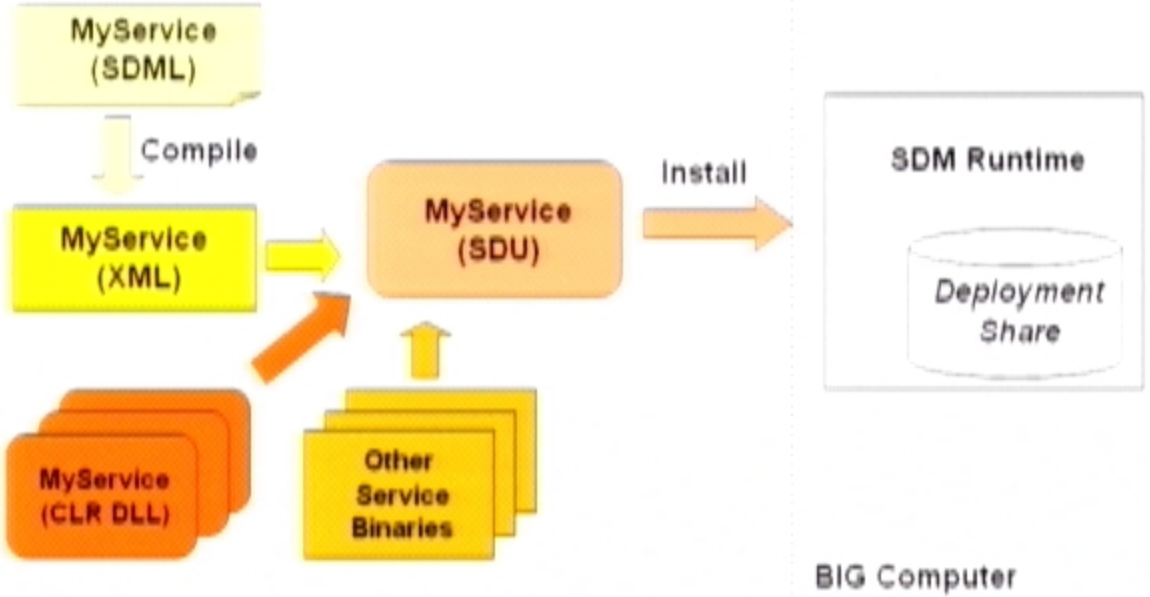


Service Deployment Unit (SDU)

- **Encapsulates all the pieces that make up a service, including**
  - *SDM model for the service*
  - *CLR assemblies for component implementation*
  - *MSI, ASP.NET, SQL scripts, Static content etc.*



SDM Runtime

- **SDM runtime is responsible for tracking SDM models and running instances**
  - *Implemented as a Web Service hosted by IIS*
  - *Exposes SOAP endpoints as SDM Runtime API*
  - *Can be partitioned for scalability*
- **Components perform operations using the SDM Runtime such as**
  - *Instantiating a component*
  - *Setting port information*
  - *Discovering peer component instances*
- **Highly available instance store (using Yukon's redundant database technology)**
  - *Two SQL servers and a witness server*
- **Security and account management using Active Directory**

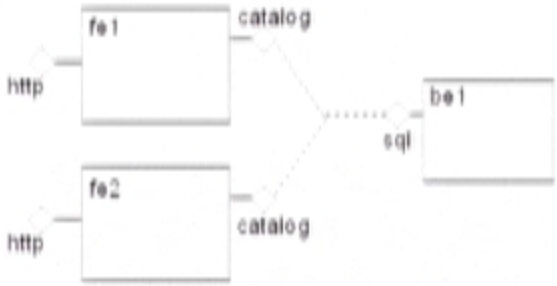
Example: Component Instantiation

```
using Microsoft.SDM;

public class MyService:
    SDMComponent
{
    public OnCreate(...)  {

    fe1 = CreateInstance("fe", "");
    fe2 = CreateInstance("fe", "");
    be1 = CreateInstance("be", "");

    w1 = CreateWireInstance("tds");
    w1.Members.Add(fe1.Ports["catalog"]);
    w1.Members.Add(fe2.Ports["catalog"]);
    w1.Members.Add(be1.Ports["sql"]);

    }
}
```

myservice.cs is C# code that uses the SDM API

```
componenttype MyService
{
    component MyFrontEnd fe:
    component MyBackEnd be:
    port http = fe.http:
    wire TDS tds (
            fe.catalog:
            be.sql:
    )
    implementation "MyService.
    MyCLRApp"
}
```

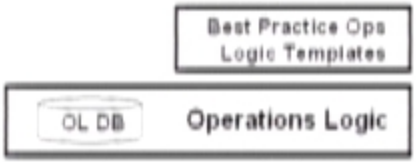
myservice.sdml



SDM Instances

Operations Logic

Services,
Components
& Operations



Operations Logic is the "Business Logic" of Operations

- **Operations Logic is CLR code that captures repeatable patterns encoded as reusable best practices**
  - *Not specific to a service or operating environment*
  - *Can be developed, tested and shipped*
  - *Reduces the need for manual procedures that require people to execute them*
- **OpsLogic is responsible for the overall operation of a service**
  - *Starting up a service*
  - *Service growth and shrinkage*
  - *Upgrades and updates*
  - *Fault detection and recovery*
  - *Database partitioning*
- **OpsLogic is implemented using MS middle-tier technologies**
  - *ASP.NET web services running on IIS*
  - *DTC for transaction coordination*
  - *SQL server for storage*
  - *WMI for monitoring and management*
  - *MSMQ for messaging*

Repeatable Upgrade Patterns → Operations Logic

- **Upgrade is an example of the type of Operations Logic we want to build and ship with BIG**

- **In-place Upgrade Pattern**
  - *Cost of moving data is high, code instantiation cost is low, or no spare resources*
  - *Takes component out of service, runs update, put it back in service*
- **Side-by-side Upgrade Pattern**
  - *Cost of moving data is low, code instantiation cost is high, have spare resources*
  - *Create new component; Take old component out of service; Migrate data to new component; Put new component into service*
- **Replacement Upgrade Pattern**
  - *No data migration*
  - *Add new components; remove old ones; coordinate to maintain service availability*

- **Rolling Upgrade is an example of higher-level operations logic that can reuse the codified upgrade patterns**
  - *Operations logic can be tested and the framework supports rollback*
  - *Removes human error from execution by letting software perform the steps*

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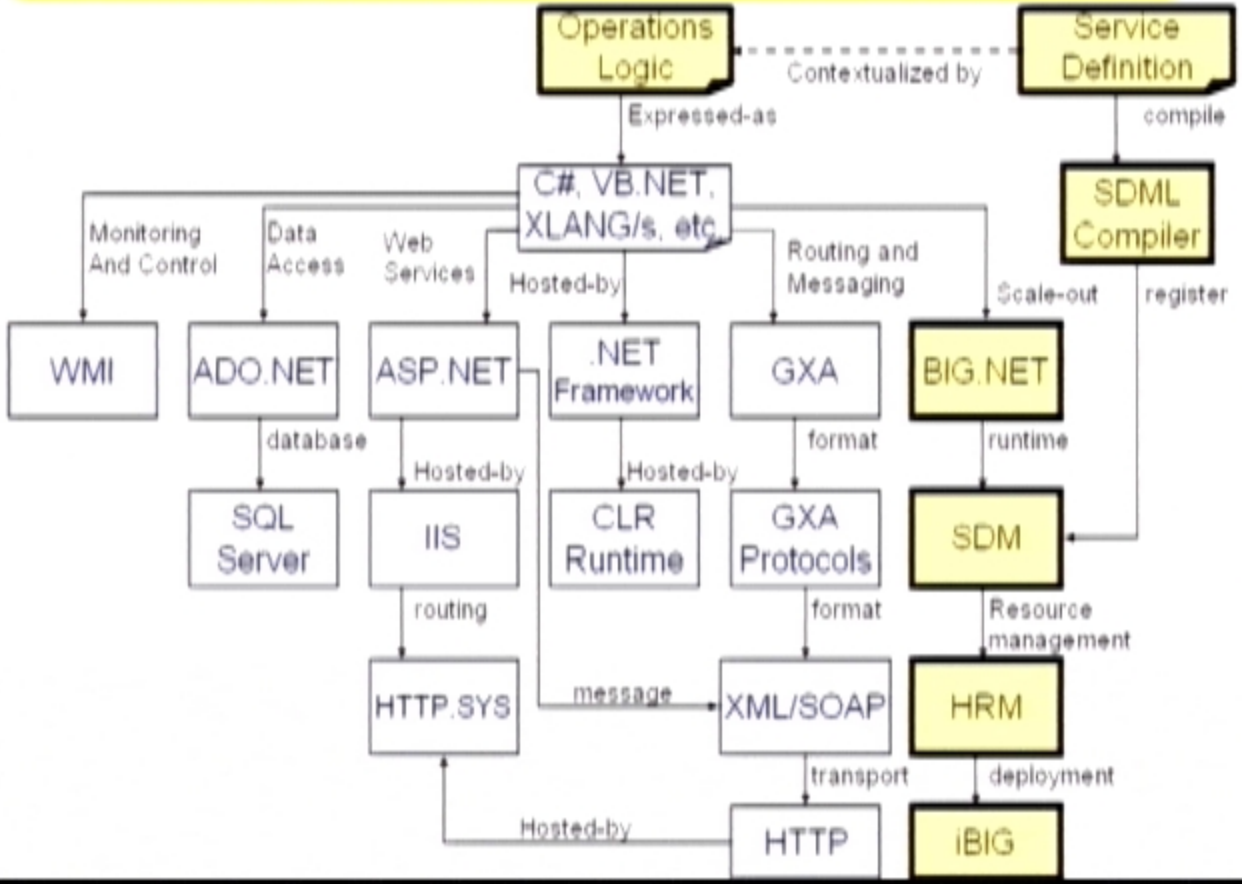
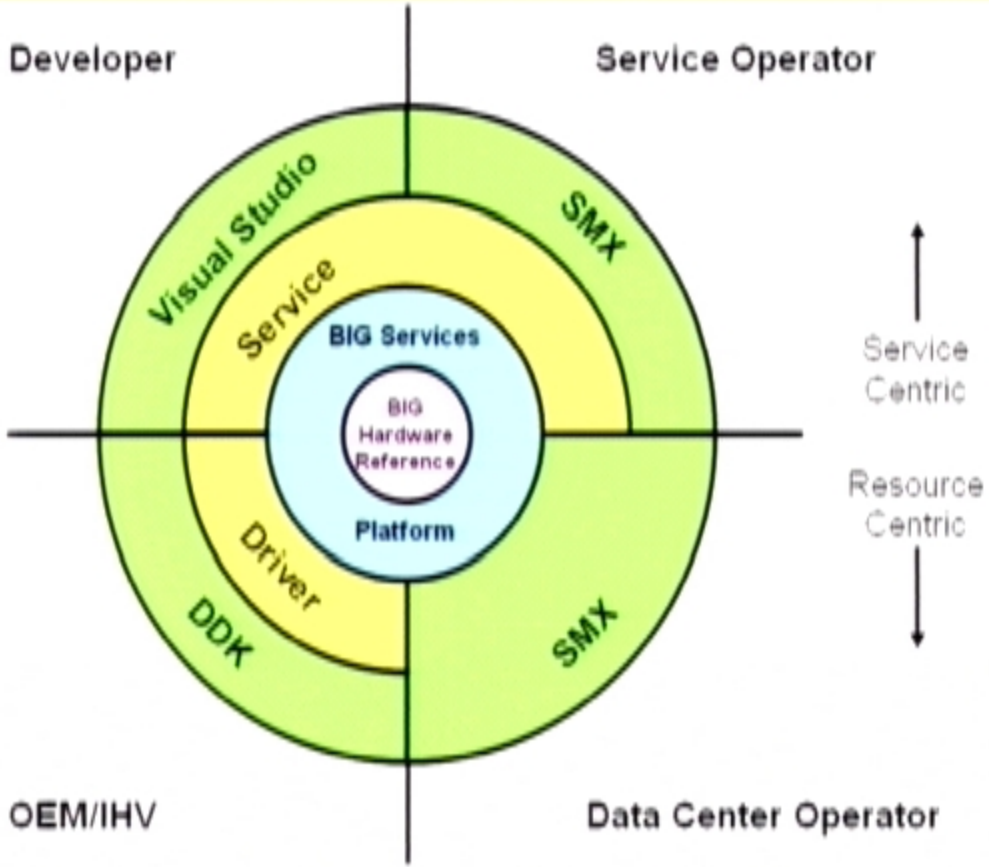
Operations Logic, BIG and the Microsoft Programming Model



Customer View of BIG



Key Customer Scenarios

- **Enterprise computing utility**
  - *IT departments as corporate computing utilities to better utilize assets by separating LOB application deployment from hardware procurement*
  - *Example: Goldman Sachs*
- **Mega-services**
  - *Large-scale services that span multiple servers performing parallel or clone functions*
  - *Example: MSN Hotmail*
- **Shared-hosting**
  - *Multiple services hosted on a single server with or without a database*
  - *Example: Schlund or Digex*
- **Diskless network boot**
  - *Enables a single image to be loaded from the network and run in RAM that is not persisted across reboots to enable centralized image management*
  - *Enables diskless server blades (lower cost/power, increases reliability and density)*
  - *Example: Morgan Stanley*

Schedule

- **Timeline:**
  - *Current team focused on spec & design of product, building core system and integration with IBIG by end-2002.*
  - *Test team and additional dev to roll-off from IBIG at end of 2002.*
- **M2 – 6/28/02**
  - *BIG computer built in lab*
  - *Standalone resource manager and drivers running on BIG computer.*
  - *Standalone runtime and components (SQL, IIS) on single machine configuration.*
- **M3 – 8/30/02**
  - *Integrated network management, resource manager and runtime on BIG computer.*
  - *BIG applications using IIS and SQL running on BIG computer.*
- **M4 – 11/22/2002**
  - *Integration with IBIG to enable bare metal deployment*
  - *System recovery support*
- **RTM - Ship by end of 2003**

Summary

- **BIG proposes a hardware reference platform to lower cost of ownership**
  - *BIG Computer simplifies design, deployment and management of distributed, scalable and highly available services*
- **BIG is developer-centric, focused on extending the Windows Server Platform for building new services using Visual Studio and reusable building blocks like IIS, SQL, …**
  - *BIG provides technology to build, deploy and operate highly available and scalable services*
- **BIG abstracts away the hardware to enable dynamic binding and re-deployment and automated network configuration**
  - *BIG delivers infrastructure such as the SDM runtime, resource management, network boot, imaging and file distribution*
- **BIG schedule is targeting end of 2003**
  - *No dependency on Longhorn*